The political economy of public research investment and commodity policies in agriculture: an empirical study

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Abstract

The paper tests a political economy theory of simultaneous government decision-making on income redistribution through commodity policies and on public research investment in agriculture. We use data from 37 countries on agricultural protection and public agricultural research expenditures (PARI). The empirical results are consistent with the political economy hypotheses. The analysis suggest that structural changes in the economy have important effects on the political incentives for governments not only to subsidize or tax farmers, but also to invest in public agricultural research. Furthermore, the analysis supports the hypotheses that the impact of such structural changes on government decision-making on PARI is non-linear and conditional on other factors. Regarding the impact of political institutions, the results suggest that more democracy neither leads to more distortionary transfers (agricultural protection), nor to lower investment in public goods (PARI). © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Agricultural protection; Public research investment; Political economy

1. Introduction

Governments intervene in the economy in many ways. Mueller (1989) distinguishes between 'redistributive' and 'allocative' policies. A well-known form of redistributive government policy is agricultural commodity policies, which have supported farmers in industrial countries and consumers in developing countries (Anderson and Hayami, 1986; Krueger et al., 1988) and which generated large economic inefficiencies and distortions in world markets (Johnson, 1991; Tyers and Anderson, 1992). An important form of allocative policy is public agricultural research investments (PARI), which are an important source of productivity growth (Anderson et al., 1994; Alston et al., 1998). Public research on the corn hybrid seed technology in the US is a classic example. Despite the overwhelming evidence of high social rates of return to public agricultural research investments, significant underinvestment persists in both developing countries

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and industrial countries (Ruttan, 1982; Huffman and Evenson, 1992, 1993).

Explanations for these stylized facts on both policy interventions take different perspectives. An important political economy literature has emerged trying to explain the pervasiveness of inefficient commodity policy world-wide and addressing why political incentives induce governments to do as they do (Gardner, 1987; de Gorter and Tsur, 1991; Swinnen, 1994; Anderson, 1995).

In contrast, most of the explanations for sub-optimal public research investment has focused on economic rather than political factors. Explanations include imperfect information of governments, difficulties in overcoming the particular nature of the 'publicness' of research (transaction costs), free rider problems and spill-ins between countries (or states within a country). Others have claimed that underinvestment may be overstated because studies ignore deadweight costs of taxation, a country's trade position, terms of trade, the differences between intermediate and finished products, the effects on unemployment, private research effects, and the impact of public research on deadweight costs of commodity policies (Schmitz and Seckler, 1970; Edwards and Freebairn, 1984; Fox, 1985; Alston et al., 1988, 1995; Murphy et al., 1993; USDA, 1995).

de Gorter and Swinnen (1998) building on earlier studies such as de Gorter et al. (1992) and Rausser (1992), use a political economic model to explain the stylized facts on redistributive (commodity) and allocative (agricultural research expenditure) policy, i.e. why industrial (developing) countries subsidize (tax) agriculture, and why underinvestment in PARI exists everywhere. A key factor in their model is how economic development changes the income distributional effects of these two types of policies, and thereby the political incentives for policy-makers. The income distributional effects of commodity policies are obvious. Also PARI has important income distributional effects between producers and consumers (Ruttan, 1982; de Gorter and Zilberman, 1990). Political considerations are therefore also important for PARI decision-making.

Furthermore, because of interaction effects between both policies, PARI and commodity policy decision-making should be analyzed in an integrated policy framework (de Gorter et al., 1992). The joint deter-

mination of commodity policy and PARI generates two types of 'interaction effects': an 'economic interaction effect (EIE)' as productivity increasing PARI can affect the deadweight costs of commodity policy, and a 'political interaction effect (PIE)' as changes in one policy affect the political support for the other policy, and so the incentives for politicians in determining the other policy. Both interaction effects influence the political optimal policy combination (de Gorter and Swinnen, 1998).

This political economy theory predicts that political support maximizing governments will reduce public investment in agricultural research with increasing inequality in distributional effects of research, and will increase income transfers through commodity policies for compensating unequal distributional effects. This effect on policy decisions can be either reinforced or mitigated by other factors which affect the distribution of incomes in the economy, including endowment income differences, deadweight costs of commodity policies, etc.

This paper tests these hypotheses on the determinants of public research investment and commodity policies in agriculture using data on agricultural protection and public good investments in agriculture from 37 countries. The empirical analysis shows that each policy is affected by inequality in either endowment incomes or in the distributional effects of public research investments, by deadweight costs associated with redistribution, by the share of agriculture in employment and by civil and political liberties.

2. Theory and hypotheses

de Gorter and Swinnen use a public choice model with two policies and two sectors: 'agriculture' and the rest of the economy — which we refer to as 'industry' — which consumes the commodities produced by agriculture. Each sector has one representative individual with a pre-policy 'endowment' income.[1] The government has two policy instruments affecting incomes in the economy: PARI and commodity policies. Commodity policies redistribute

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[1] The theoretical discussion here ignores the impact of the size of the sector. We discuss its impact in the empirical specification of the model.

income between sectors, involving deadweight costs.[2] Typical commodity policies in agriculture include price supports, export subsidies and trade barriers.

PARI is a public good that increases productivity and overall welfare, but which may affect the two sectors differently. Each sector's share of the PARI benefits depends on the elasticity of supply and demand and on the effects of research on agriculture's cost structure (de Gorter and Zilberman, 1990). For example, a large cost reduction in agriculture due to research with an inelastic demand could have industry benefiting more than agriculture.

Economic development will therefore affect the distribution of the benefits from PARI. Typically, the richer the country the more price inelastic is food demand. Furthermore, industrial countries have relatively elastic supply curves for agriculture, while supply is more inelastic in developing countries (Binswanger et al., 1985). In this perspective, Schultz (1953) distinguishes the 'farm problem' in industrial countries, where farmers benefit relatively less from technology with inelastic demand, from the 'food problem' in developing countries with elastic demand. This implies that one would expect that in industrial countries PARI favors industry while in developing countries agriculture benefits relatively more from PARI.

As each policy has a differential impact on the distribution of income, each sector has a different preference for PARI and the commodity policy and will react to government decisions depending on how the government policies differ from their preferred policy. Commodity policy and PARI are assumed to be determined jointly by rational government choice, given the political constraints of the government.[3]

More specifically, the government chooses the policy combination that maximizes political support. Political support is a function of the changes in welfare induced by both policies.[4] Policy-induced changes in welfare depend on the structure of the economy and the specific policy.

The *political optimal* policy combination depends, *inter alia*, on the relative pre-policy endowment incomes between agriculture and industry, on the distributional impact of PARI, and on the deadweight costs associated with the commodity policy. To explain the correlation between economic development and changes in the observed (political equilibrium) policy combinations, we analyze how structural changes in the economy (such as a change in the distribution of research benefits) coinciding with economic development affects the political optimal policies. The discussion here summarizes some key insights and we refer to de Gorter and Swinnen (1998) for an extended (and formal) analysis. We focus particularly on the impact of changes in the sectoral distribution of PARI benefits and on endowment incomes on the political optimal PARI and commodity policy levels.

2.1. Impact of structural changes on politically optimal commodity policies

Redistributive transfers increase to a sector experiencing a fall in relative endowment incomes (see Fig. 1).[5] The intuitive explanation is as follows: if agriculture's endowment income falls, then agriculture will experience a larger marginal change in utility

[2] We ignore the important issue of why redistribution takes place through distortionary commodity policies and not through lumpsum transfers. Foster and Rausser (1993) show that price and trade policies can be a preferred policy over lump sum transfers when redistribution is used to reduce opposition to growth promoting policies by selectively compensating for adverse income effects.

[3] In reality, the two policies may be decided by different parts (e.g., administrations) of the government; they may have different time (dynamic) effects, and private research is also undertaken. To capture the essence of these features, agents are assumed to have perfect foresight in including future costs and benefits in their valuations. Even if different institutions are involved in the decision-making, those institutions do not act independently of one another as they take each others' actions into account. This specification is a simplified way of modeling this.

[4] The model is an extension of the public choice model of Swinnen and de Gorter (1993) and Swinnen (1994) by introducing PARI as a second policy. This approach ensures a stable and unique equilibrium within a two-policy framework and allows for comparative static analyses to derive the impact of structural changes in the economy which coincide with economic development.

[5] Fig. 1 presents simulations results of the impact of a change in agricultural endowment income while sector B's endowment income was held constant. The simulation assumes that PARI benefits are distributed equally between sectors. The distribution of PARI benefits does not affect the sign of the impact of relative endowment incomes on politically optimal transfers. It does affect the transfer level itself. For example, the political optimal transfer would not be zero when endowment incomes are equal if the distribution of PARI benefits was unequal.

Fig. 1. Impact of relative endowment incomes on politically optimal commodity policy.

induced by a given transfer. Consequently, agriculture's per capita political reaction will increase relative to that of industry. Politicians can then increase total support by redistributing income to the sector that experiences a decrease in relative endowment income. The reduction in support from the high income sector is more than offset by the gain in support from the lower per capita income sector (Swinnen and de Gorter, 1993).

Sectoral subsidization through commodity policy is negatively related with the sector's share of PARI benefits (see Fig. 2). In other words, a sector that benefits relatively less (more) from PARI is compensated (taxed) through commodity policy. To understand this, consider the case where agriculture benefits less than industry from PARI. Politicians respond to the differential income effects of PARI in a similar manner as they do to endowment income gaps. Commodity policy transfers are implemented to compensate the sector (agriculture in this example) that benefits less from PARI.

The optimal commodity policy transfer depends on the size of the endowment income differential relative to the differential income effect of research. For
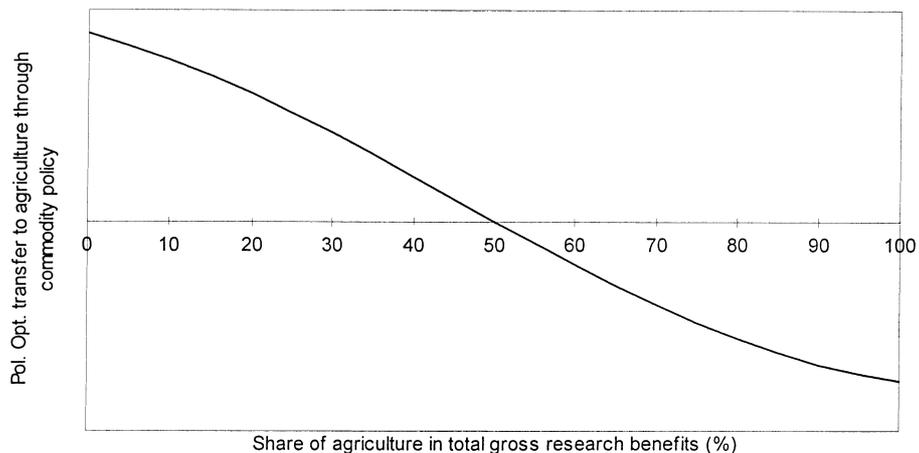

Fig. 2. Impact of PARI benefits distribution on politically optimal commodity policy.
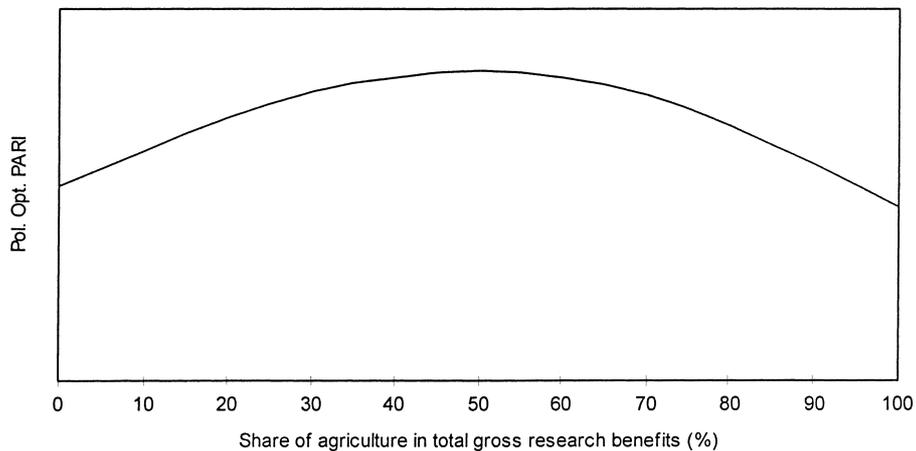
Fig. 3. Impact of PARI benefits distribution on politically optimal PARI.

example, if agriculture's endowment income is relatively lower but agriculture gains relatively more from research, then the transfer can be either positive, zero, or negative.

2.2. Impact of structural changes on politically optimal PARI

The impacts of structural changes on the politically optimal PARI is conditional on the structure itself. Fig. 3 illustrates how the impact of a change in the relative benefits of PARI depends on the initial distribution of PARI.[6] To understand the intuition behind these results, consider the case where agricultural producers benefit more from PARI research (i.e. the right-hand side of Fig. 3). If agriculture's share of PARI benefits increased further, the government will need to increase compensation to industry. This implies an increase in deadweight costs, which will reduce the optimal PARI. In addition, this increase in deadweight costs will increase commodity policy taxation on agriculture. The induced increase in deadweight costs will negatively affect total compensation payments through commodity policies. This will further increase industry's opposition to investing more in PARI than industry's sectoral optimum. Both effects will reinforce each other and so reduce politically optimal PARI (as is illustrated in Fig. 3).

Now consider the case where agriculture initially benefits less from PARI (the left-hand side of Fig. 3). An increase in agriculture's share of PARI benefits will raise the lower of the two optimal individual sectoral investment levels. This induces an increase in the political optimal investment level because it reduces both the amount of compensation going to agriculture through commodity policies (as agriculture benefits more from PARI now) and the associated deadweight costs. Again, both factors reinforce each other causing PARI to go up (see Fig. 3).

PARI is highest when both sector's preferences for PARI are identical. In Fig. 3 this is when both sectors benefit equally from PARI, i.e. when agriculture's share of PARI benefits is 50%. In this case the politically optimal PARI equals the social optimal PARI. In all the other cases in Fig. 3 'underinvestment' results, i.e. the politically optimal PARI is below the social optimum.[7]

Changes in endowment incomes also have a conditional effect on political optimal PARI levels. The

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[6] The discussion assumes that there are no endowment income differences. In case endowment income differences are the same as the PARI distribution effects (i.e. favoring the same sector) then both factors reinforce one another. When relative endowment incomes are opposite to that of research benefits, there are offsetting effects of a change in PARI distribution and the net effect depends on the relative importance of the differences.

[7] 'Overinvestment' may also occur; for example, when endowment incomes are unequal and PARI is used for redistributive purposes. This is not captured by Fig. 3 which is based on the assumption that endowment incomes are equal.

impact depends on the distribution of PARI benefits between agriculture and industry: a lower endowment income for a group will increase (decrease) PARI if the group benefits more (less) from PARI. For example, if agriculture benefits more than the rest of the economy from PARI, then there is a negative impact of an increase in farmers' endowment income on equilibrium PARI, and vice versa.

The intuition behind these results is that when the PARI benefits are distributed unequal and when income transfers through commodity policies induce deadweight costs, the government will also use PARI for redistributive purposes. If agriculture benefits more from PARI than industry, the government will compensate agriculture for a decrease in endowment income by a combination of increasing PARI and by increasing transfers to agriculture. As PARI benefits agriculture relatively more, politicians are better to use this (non-distortionary) policy to compensate agriculture for exogenous changes in income. In contrast, when agriculture benefits relatively less from PARI, a relative fall in endowment income will induce politicians to redistribute income to agriculture. Notice that this can only be through the commodity policy and that this redistribution is in addition to existing compensation for less PARI benefits. The impact on PARI is now opposite: the accompanying increase in deadweight costs with increased commodity policies will increase the opposition to transfers, and thus to compensation for PARI investment. This will reduce the politically optimal PARI.[8]

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[8] The discussion here ignores the economic interaction effects (EIEs), i.e. the impact of PARI on the deadweight costs caused by the commodity policies. The impact of the PARI on deadweight costs of commodity policy is widely discussed in the literature with most papers arguing that the PARI increases deadweight costs (Alston et al., 1988; Murphy et al., 1993). However, these conclusions are based on the assumption of a *fixed policy instrument level*. But with a cost-reducing PARI induced supply shift, both producers' incomes and transfers to producers increase with a fixed policy instrument level. Hence, results based on this assumption are irrelevant for our current analysis. In fact, in several cases PARI may reduce the commodity policy deadweight costs *per unit of transfer* (Swinnen and de Gorter, 1998). In this case the reduction in per unit deadweight costs provides an (additional) incentive for governments to increase PARI. Including EIEs complicates the effects substantially but does not change the general results as presented here.

3. The empirical model

To test these hypotheses on the determinants of public research investment and commodity policies in agriculture we use data on agricultural protection and public good investments in agriculture from 37 countries. The empirical model which we will estimate can be summarized as a joint distribution:

$$(t^*, \tau^*) = F(\beta, y_e, X, Z, T, I) \tag{1}$$

where t^* is the politically optimal level of income transfer to farmers through commodity policies, and τ^* is the politically optimal level of PARI. Both are functions of the distribution of research benefits (β) and the pre-policy endowment income (y_e) in each sector. The term X is a vector of structural variables that affect the optimal policy choice, including an indicator variable reflecting the deadweight costs associated with the commodity policy t. The variables Z and T are composed of regional and time qualitative variables, respectively, that transform the model into a 'fixed effects' transformation model. The latter is supposed to capture additional systematic variation that is due to the combination of cross-sectional and time-series data (Mundlak, 1978). The vector I represents variables reflecting differing political and civil institutions across countries and over time.

A number of proxies or indicator variables are used for the variables in the estimation.

3.1. Dependent variables

ARG is the indicator for PARI and is calculated as the ratio of agricultural research expenditures over GDP. Data for the agricultural research expenditures are collected by ISNAR and reported in Pardey and Roseboom (1989).[9] GDP is taken from the World Bank World Tables (STARS). All prices were converted using 'real exchange rates' as reported in the Penn World Tables.

Redistributive transfers to agriculture are measured by an adjusted nominal protection coefficient (NPC) that includes direct taxpayer price subsidies. This

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[9] See also Anderson et al. (1994) and Alston et al. (1998) for a review of agricultural research investments across time periods and countries.

Table 1
Expected signs of the explanatory variables in the regressions

(a) Dependent variable = nominal rate of protection (NPC)

PCGDP	+
ENDOW	+
AGTRADE	−
AGLABOR	−
AGLAND	−
AGSHARE	+

(b) Dependent variable = agricultural research expenditures (ARG)

	Country per capita income[a]	
	LOW	HIGH
PCGDP	+	−
ENDOW	+	−
AGLABOR	+	−
AGLAND	+	−

[a] LOW = PCGDP < 7500 (US$ per capita); HIGH = PCGDP > 7500 (US$ per capita).

variable was calculated from three sources of protection in agriculture: the OECD and USDA 'producer subsidy equivalent' datasets and the Krueger, Schiff and Valdes World Bank project. The latter generated data on rates of protection in agriculture for 18 developing countries.

3.2. Structural variables

Table 1 summarizes the hypotheses on how several structural variables affect NPC and ARG, including the differential impacts of these variables in the high and low income countries.

The proxy for distributional effects of PARI (β) is a difficult issue. The richer the country, the more price inelastic is food demand because of the relationship between income and price elasticities given by the Cournot condition in demand theory. Furthermore, industrial countries have relatively elastic supply curves for agriculture while supply is extremely inelastic in developing countries (Binswanger et al., 1985). Consumers tend to gain from research relative to farmers when demand is inelastic and supply is elastic (de Gorter and Zilberman, 1990). This means one would expect consumers to benefit relatively more in industrial countries while farmers benefit relatively more in developing countries. Therefore, per capita GDP (PCGDP) in 1985 $ is chosen as an indicator for

the value of β. Obviously, PCGDP is an imperfect proxy for the share of PARI benefits and may also reflect other factors. For example, as per capita GDP increases tax revenues increase relative to GDP, i.e. the supply of research funds may increase.

Relative pre-policy endowment incomes (ENDOW) are measured by the ratio of value added in industry over value added in agriculture, adjusted for protection induced income as measured by the NPC. In addition, we use the amount of land per capita (AGLAND) as a proxy for the truly fixed relative endowment incomes in agriculture. ENDOW can be viewed as a proxy for endowment income as 'produced income' while AGLAND is a proxy for 'fixed income'. We expect AGLAND to have the same conditional sign on research policy as ENDOW while having a negative effect on the nominal protection coefficient.

Other variables capturing structural characteristics are AGLABOR, AGSHARE, and AGTRADE. AGTRADE measures net exports in real terms and is a proxy for (increasing) deadweight costs of protection to agriculture and so is expected to have a negative impact in the equation explaining protection to agriculture. AGSHARE is the share of agriculture in GDP and is a proxy of the relative size of the 'vested interest' in agriculture. The larger size of the sector increases the demand for protection and so we expect a positive sign of this variable in explaining protection to agriculture (Swinnen, 1994). AGLABOR is a proxy for the relative group size and is measured as the share of agriculture in total employment. Protection is expected to increase to a sector with decreasing employment shares. As the number of individuals in a sector decreases relative to that of another sector, for a given per capita transfer the per capita tax on the rest of the economy decreases. This reduces opposition against protection. However, there are now relatively more people who are taxed and fewer who benefit by the protectionist policy. The combined impact is determined by the differential impact due to the concavity of the utility and support function, which implies that the per capita transfer to the protected sector unambiguously increases (Swinnen and de Gorter, 1993). Collective action models emphasize this factor for a different reason. They attribute the increase in agricultural protection importantly to the increased ability of farmers to organize politically as

their numbers decline, and hence, free-riding problems become less important (Olson, 1985).

As explained in Section 2, the impact of several structural variables on research expenditures (ARG) are non-linear and conditional on other factors. The impact of structural variables, such as PCGDP, ENDOW, AGLAND and AGLABOR are expected to depend on the distribution of PARI benefits, for which PCGDP is an indicator, and on endowment income differences, for which ENDOW is an indicator. To account for these effects, the dataset is decomposed into two parts with PCGDP = 7500 (real 1985 US$ per capita) as cut-off point: the high income countries (PCGDP > 7500) and low income countries (PCGDP < 7500). (Any number between US$ 5000 and 9000 per capita would have yields results very similar because there are relatively few observations within this range).[10]

To test the differential impact of the structural variables on ARG in the two parts of the dataset, we used slope dummies by multiplying DumLOW (indicator for low income countries) and DumHIGH (indicator for high income countries) with PCGDP, ENDOW, LAND and LABOR, creating variables like PCG-LO, PCG-HI, EDW-LO, EDW-HI, LND-LO, LND-HI, LAB-LO and LAB-HI, respectively. According to our hypotheses (see Table 1b), we expect the signs of the slope coefficients of these variables to change from positive (LOW income) to negative (HIGH income), as illustrated by Fig. 3 for the distribution of PARI benefits, captured here by the PCGDP variable.

3.3. Political institutions variables

Policy making is affected by the institutions that determine the framework for decision-making. The conceptual model discussed above assumes that the institutional framework is constant. However, since the data cover a wide range of countries with very different civil and political institutions, additional variables have been included in the empirical model to capture the impact of important variations in political institutions.

Changes in political institutions affect the ability of the interest groups to influence the government policies. While there is an extensive literature on the impact of political systems on economic performance and on macro-economic policies (Olson, 1982; Scully, 1988; Przeworski and Limongi, 1993). There is less research done on the impact of political institutions on sectoral transfers or public investments. Studies by Beghin and Kherallah (1994) and Beghin et al. (1996) suggest that increases in democracy (access to pluralism) increases agricultural protection, although not in a linear fashion, i.e. beyond some minimal level further democratization does not induce more protection.

Measures of political and civil liberties are given by Freedom House ratings (Gastil, 1987). The ratings go from 1 to 7, with 1 being the most free or with the most rights and 7 with the most restricted rights. For example, most Western European countries have a political rights ranking of 1. McMillan et al. (1993) provide a summary of Freedom House variables. Civil liberties variables were not included in the model because of correlation with the political liberties variables. We used the following qualitative variables to measure the political rights rankings: POL12 = 1 for political rating 1 and 2, and = 0 otherwise; POL35 = 1 for political rating 3 to 5, and = 0 otherwise. Political ratings 6 and 7 were used as the base class.

3.4. Regional and time qualitative variables

This last group of variables captures additional systematic variation. Regional variables are defined as AMERO (North and South American countries and Australia and New Zealand), AFRIC (African countries), ASIAN (Asian countries), EU (EU member countries) and EUROP (non-EU European countries). Quantitative time variables were constructed for each year.

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[10] In theory, there are 2^n subsets of the data with n 'sources' of structural inequalities which could affect the sign of the impact of the structural variables on ARG. For example, with both the distribution of PARI benefits and endowment income differences (as discussed in Section 2) there should be four data 'quadrants'. However, using NPC = 1 as a cut-off point for the endowment income difference, there were few observations in the 'quadrant' which had NPC > 1 and PCGDP < US$ 7500 and almost none in the 'quadrant' with NPC < 1 and PCGDP > US$ 7500. Hence, using PCGDP = US$ 7500 as a separation point for the dataset in two subsets empirically captures most of the structural separation in the dataset.

4. Regression results

NPC and ARG are jointly determined in the political economy theory. Empirically, this translates into a correlated jointly estimated system of equations. Therefore, in accordance with the theoretical analysis in Section 2, and the empirical model as summarized in Eq. (1), we have jointly estimated LogNPC and LogARG in a two-equation system, with our explanatory variables, using a full information maximum likelihood (FIML) technique.

We used monotonic transformations of the variables in the analysis: for the variables NPC, ARG, PCGDP, AGLABOR, AGSHARE and ENDOW, we used the natural log transformation and named them as

LogNPC, LogARG, LogPCGDP, LogLABOR, Log-LAND, LogSHARE and LogENDOW, respectively. In the NPC regression we further included a dummy for the high income countries (DumPCGDP-HI) to test for non-linearity of the relationship between LogNPC and LogPCGDP.

The aggregate dataset actually used in the regression included annual data between 1972 and 1985 from 37 countries. Table 2 presents the estimation results.

In the LogNPC equation (Model 1) the signs for all of the key variables are consistent with our hypotheses. In addition, the t-ratios are relatively large. The negative coefficients of LogENDOW and LogLAND support our hypothesis that agricultural protection is

Table 2
Full-information maximum likelihood estimation

Variables	MODEL 1			MODEL 2			MODEL 3		
	Coefficient	t-values	Probability	Coefficient	t-values	Probability	Coefficient	t-values	Probability
Dependent variable: LogNPC									
INTERCEPT	0.375	3.362	0.001	0.373	3.839	0.000	0.542	5.613	0.000
LogPCGDP	0.285	3.519	0.001	0.169	3.043	0.003	0.434	6.951	0.000
DumPCGDP-HI	0.268	2.814	0.005	0.474	6.871	0.000	–	–	–
LogENDOW	0.321	15.906	0.000	0.356	17.595	0.000	0.315	15.540	0.000
AGTRADE	−0.788	−2.653	0.009	−0.851	−2.789	0.006	−0.732	−2.428	0.160
LogLAND	−0.088	−4.514	0.000	−0.064	−3.366	0.001	−0.098	−5.105	0.000
LogLABOR	−0.378	−7.911	0.000	−0.331	−6.674	0.000	−0.393	−8.168	0.000
LogSHARE	0.369	8.923	0.000	0.386	8.909	0.000	0.367	8.697	0.000
POL12	−0.098	−1.910	0.058	−0.086	−1.585	0.115	−0.061	−1.230	0.220
POL35	−0.093	−1.856	0.065	−0.062	−1.251	0.212	−0.122	−2.450	0.015
AFRIC	0.232	2.742	0.007	–	–	–	0.347	4.618	0.000
AMERO	0.007	0.144	0.885	–	–	–	−0.054	−1.166	0.245
ASIAN	0.102	1.774	0.078	–	–	–	0.109	1.882	0.613
EUROP	0.221	4.646	0.000	–	–	–	0.212	4.427	0.000
Dependent variable: LogARG									
INTERCEPT	−3.200	−14.172	0.000	−3.160	−14.164	0.000	−3.141	−14.028	0.000
LogPCGDP-HI	−0.985	−2.226	0.027	−0.976	−2.208	0.028	−0.941	−2.121	0.035
LogPCGDP-LO	0.742	3.027	0.003	0.644	2.688	0.008	0.835	3.445	0.001
LogENDOW-HI	−0.498	−4.968	0.000	−0.508	−5.048	0.000	−0.457	−4.560	0.000
LogENDOW-LO	−0.002	−0.047	0.963	0.030	0.598	0.551	−0.012	−0.252	0.801
LogLAND-HI	−0.112	−2.054	0.041	−0.118	−2.183	0.030	−0.091	−1.693	0.092
LogLAND-LO	0.183	3.369	0.001	0.210	3.886	0.000	0.164	3.045	0.003
LogLABOR-HI	0.527	0.384	0.701	0.103	0.749	0.455	0.044	0.323	0.747
LogLABOR-LO	1.061	6.742	0.000	1.099	6.985	0.000	1.051	6.664	0.000
POL12	−0.104	−0.789	0.431	−0.079	−0.591	0.555	−0.94	−0.714	0.476
POL35	−0.350	−2.571	0.011	−0.324	−2.377	0.018	−0.370	−2.726	0.007
AFRIC	1.859	7.654	0.000	1.673	7.211	0.000	1.914	7.941	0.000
AMERO	1.061	8.080	0.000	1.039	8.260	0.000	1.024	7.825	0.000
ASIAN	1.231	7.801	0.000	1.153	7.668	0.000	1.218	7.737	0.000
EUROP	0.467	3.741	0.000	0.285	2.402	0.017	0.447	3.594	0.000

Table 3
Tests for significant changes in the slope of structural variable coefficients between high-income to low-income countries for the LogARG estimation

Hypothesis	F-value	Probability $> F$	Result
Model 1			
Coeff(LogPCGDP-HI) = Coeff(LogPCGDP-LO)	10.218	0.001	Rejected
Coeff(LogENDOW-HI) = Coeff(LogENDOW-LO)	21.039	0.000	Rejected
Coeff(LogLAND-HI) = Coeff(LogLAND-LO)	26.137	0.000	Rejected
Coeff(LogLABOR-HI) = Coeff(LogLABOR-LO)	21.842	0.000	Rejected
Model 2			
Coeff(LogPCGDP-HI) = Coeff(LogPCGDP-LO)	10.892	0.001	Rejected
Coeff(LogENDOW-HI) = Coeff(LogENDOW-LO)	16.961	0.000	Rejected
Coeff(LogLAND-HI) = Coeff(LogLAND-LO)	20.621	0.000	Rejected
Coeff(LogLABOR-HI) = Coeff(LogLABOR-LO)	21.541	0.000	Rejected
Model 3			
Coeff(LogPCGDP-HI) = Coeff(LogPCGDP-LO)	9.202	0.003	Rejected
Coeff(LogENDOW-HI) = Coeff(LogENDOW-LO)	25.129	0.000	Rejected
Coeff(LogLAND-HI) = Coeff(LogLAND-LO)	33.798	0.000	Rejected
Coeff(LogLABOR-HI) = Coeff(LogLABOR-LO)	21.681	0.000	Rejected

used to offset endowment income inequality. There is a further positive impact of growth in LogPCGDP on agricultural protection, which our model suggests is due to a reduction in the share of research benefits for farmers. The positive and significant effect of DumPCGDP-HI further suggests that the relationship between LogNPC and LogPCGDP is non-linear. Comparison with Models 2 and 3 show that there is some interaction of this effect with the variation captured by the regional dummies.

The negative coefficients of AGTRADE and LogLABOR are consistent with our hypotheses on the negative impact of deadweight costs of market interventions and of the agricultural employment share. The positive sign of LogSHARE reflects the positive impact of the size of the vested interest in agriculture on agricultural protection.[11]

The coefficients of the political rights variables (POL12 and POL35) are negative, suggesting that *ceteris paribus* institutional changes towards greater

democracy does not seem to induce higher protection to agriculture, a different result than that obtained by some other studies (see above). The coefficients of POL12 and POL35 are very similar, suggesting that moving from low to medium political rights is associated with a reduction in agricultural protection, but that further changes in political rights have no influence on the level of protection. The t-values are lower than those of the structural variables, suggesting that either the influence of political rights on agricultural protection is limited or that part of the effect is captured by PCGDP due to collinearity between political rights and economic development (the correlation coefficient between POL12 and PCGDP is 0.67).

The LogARG equation (Model 1) gives the empirical results for research expenditures. The results are consistent with the hypothesis that the impact of the explanatory variables is conditional on the structure of the economy. All the structural variables which have a significant impact have the predicted sign (see Table 2). Moreover, all the structural variables show a significant change in their impact on ARG between the low and high income countries (see Table 3) and in all cases the change is in the predicted direction.

More specifically, the impact LogPCGDP, LogENDOW, LogLAND and LogLABOR changes from

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[11] This differential effect of the labor share (negative) versus the output share (positive) of agriculture on agricultural protection is consistent with other analyses which have included variables to test for both hypotheses simultaneous, such as Swinnen et al. (1998) analysis of agricultural protection in Belgium between 1875 and 1990.

significantly positive (or insignificant for LogEN-DOW) in low income countries to significantly negative (or insignificant for LogLABOR) in high income countries. As the analysis in Table 3 shows, for all these variables the change in coefficients is significant at the 1% level. Hence, we can conclude that these empirical results strongly support the theoretical hypotheses that the impact of the structural variables is conditional and non-linear, as illustrated by Fig. 3.

The coefficient of POL12 is not significant, unlike the POL35 variable which has a significant negative impact. The results suggest that the impact of political rights is also non-linear since there is little difference, *ceteris paribus*, between low and high political rights regimes on public investment in agricultural research; however medium rights countries invest significantly less than the other countries.

While one should be careful in the interpretation of these variables given the potential correlation with PCGDP, the results are not consistent with the hypotheses that more political rights lead to greater under-investment in PARI with more interest groups fighting for budgetary resources. In fact, political institutional reforms shifting a country from the medium level political rights (POL35) to the high rights group (POL12) is positively correlated with PARI.

In general, the results of the NPC and PARI regressions in terms of the political rights variables are encouraging for supporters of democracy: they suggest that more democracy does neither lead to more distortionary transfers (agricultural protection), nor to lower investment in public goods (PARI).

The large *t*-statistics of the regional variables in the ARG equation suggest important additional variation between the regions which is not captured by the variables in the model.

Explanations for distortionary commodity policies have focused mostly on political economy arguments, while most of the explanations for sub-optimal public research investment has focused on economic factors, such as imperfect information, transaction costs, etc. de Gorter and Swinnen (1998), building on earlier studies such as de Gorter et al. (1992) and Rausser (1992), propose a political economy theory of joint decision-making on public agricultural research investment (PARI) and commodity policies in agriculture to explain the stylized facts on both commodity policies and PARI.

This paper provides a test of the de Gorter and Swinnen (1998) hypotheses using time series and cross-section data on agricultural protection and PARI in 37 countries.

Our empirical results are consistent with the theoretical predictions. The analysis suggest that structural changes in the economy have important effects on the incentives for politicians in government not only to subsidize or tax farmers, but also to invest in public agricultural research. Furthermore, the analysis supports the hypotheses that the impact of structural variables on government decision-making on PARI is not linear, as in the case of protection. For example, the impact of factors such as the distribution of PARI benefits, relative endowment incomes, and relative group sizes on the level of PARI are themselves conditional on the structure of the economy.

Finally, our empirical results do not support arguments that institutional changes leading to more political freedom and rights for citizens have a negative impact on sound economic policy-making. Our results suggest that more democracy neither leads to more distortionary transfers (agricultural protection), nor to lower investment in public goods (PARI).

5. Conclusions

Governments have implemented agricultural commodity policies to support farmers in industrial countries and consumers in developing countries, causing large economic inefficiencies and distortions in world markets. At the same time, governments have invested in agricultural research (PARI), but, despite its high social rates of return, at sub-optimal levels both in developing and industrial countries.

Acknowledgements

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